EXPERIMENTS ON THE FORM OF CAST-IRON GIRDERS.

SIR,—The following experiments are submitted, as laying before you, in a very simple form, first, the proportionate values or strengths of the simplest forms of cast-iron beams, as applicable to constructive purposes; and, secondly, the positive value of the application of the wrought-iron tension-bar or rod to the same, as a means of adding increased value in strength; and that the investigation is at this moment imperatively called for, the experience of the last few months witnesses.

It appears a little singular that the use of the tension-bar, as a means of adding strength to the bearing purposes of cast-iron, should have so largely obtained without the same having been based upon actual experiment, and, still more strange, that it should almost invariably have been used in such a position, that its presence not only adds nothing to the security sought, but that its application has really been one of the elements of destruction to the beam to which it has been so attached (as see experiments to be given in a following paper).

That the application of a superior tensile material, as wrought-iron undeniably is, to cast-iron for structural purposes, and especially in combination with cast-iron as *its* superior to resist compression, is a proper subject for earnest research, and a desideratum to a large and extensive interest, is without doubt; and that such an investigation yet remains to be performed, is also true. Such an inquiry should, in my opinion, be pursued by actual experiment, based upon the dissimilar properties of the two materials; the one superior to the other for its tenacity, to be reserved only to that use, whilst the other, again *its* superior in the facility with which it admits of being put in preferable forms to resist compression, to be reserved to that purpose only. This, I believe, is the present question, and one of more real moment to the public, when seriously reflected upon, I scarcely know; for, when contemplating the existing lines of communication into which the combination of the two materials has entered so largely in their various structures, the consequences of failure in any of them is seen to be terrific.

In briefly noticing the accompanying experiments, the first portion relates wholly to the simplest forms in which cast-iron can be used as bearing beams, and as leading on to the perfecting our knowledge of the value of the various useful forms of which it is susceptible. The results there manifest will bear reiteration. 1st, *Experiments A* are commenced as a foundation, the bars bearing 482 times their own weight, with a deflection one-thirteenth of their depth. 2ndly, in *Experiments B*, notice the breadth and consequent quantity of material doubled, producing but 1½ the strength, its stiffness or deflection remaining only the same, bearing but 403 times its own weight, or a loss of 12 per cent. This is a point, in the proper disposition of materials, often of much importance, and, as a caution, needs to be prominently put forward, for the mind is but too apt to recognize without exception the product of two and two to be four. Its stiffness, also remark, remains identical with experiments A, notwithstanding the large increase of material, the length and depth being still the same.

Experiments C afford a further illustration of the same result, the quantity remaining similar or rather increased,—though the beam consists of separate pieces, nothing better is arrived at,—we still witness the diminution of strength: although a small gain in stiffness or lesser deflection is produced, this may be accounted for by the fact of their being in distinct castings. Each has its separate surface or skin, which is in a measure chilled or stiffened in its cooling from the melted state. It increases the value of stiffness but not of ultimate strength. It was also remarked, during the progress of each of the three experiments C, that the beam appeared to lie under disadvantage peculiar to itself. Supposing two beams in practice similar to those now under consideration, it would be practically impossible to produce the two in all parts alike as to weight, scantling, and perfection of body, surface, and quality of material. Reasoning, then, that one of the two would be the weaker, does not *that* weakest, by its yielding first to the force acting upon it according to its own strength, involve, by its such destruction, the destruction also of its fellow, and so produce but a double strength of the weakest, instead of a combined strength of the two? If so,—and it appears but reasonable so to argue,—how fully does it point to the necessity of exceeding carefulness of supervision, where, as in large structures, generally dependent one part on another, one part in its failure involves such extensive ruin!

Experiments D.—These three experiments entering into a comparison with either B or C, bear undoubtedly high upon the question of the best disposition of the material, recollecting, at the same time, we are not advocating a section or attempting to produce in this inquiry the best of all sections for practical purposes, but merely instituting comparisons with a determinate quantity of material. It is remarkable here to witness the great increase of strength, although not accompanied by stiffness,—the gain in strength being 25 per cent. upon experiment A: the loss in stiffness being 30 per cent. The strength arising from the accumulation of the quantity submitted to tensile action bears out an adequate result, or 580 times its own weight, instead of 400, as B and C, shewing over them an increase of strength of nearly 50 per cent. In using this section, it makes no difference whether the load be placed wholly upon the upper part of the vertical web or whether it be placed upon the *lower* flanches or webs, the result obtained in either case was the same. This form of section in this series of experiments, it will be seen, is much to be preferred to any other (even inclusive of the following, viz., those which were trussed by the addition of the wrought-iron bolt), and it, as a basis for further consideration of the best form, deserves attention, and perhaps, for practical purposes, it may, on account of its simplicity, as being more readily borne in mind, be preferred to a more complex and better studied form.

A.—Transverse Strain on a simple Rectangular Iron Beam, 24 in. long, 2 in. high, and ½ in. thick.

The pressure of the lever and scale in all these experiments was 220 lbs.

The pressure of the lever and weights were severally as under.

No. 1 Experiment. Weight, 534 oz.		No. 2 Experiment. Weight, 54 oz.		No. 3 Experiment. Weight, 55 oz.		No. 4 Experiment. Weight, 56 oz.	
Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.
520	·06	520	·04	520	·061	520	·04
580	·067	580	·046	592	·068	580	·044
652	·074	652	·052	652	·074	652	·051
712	·080	712	·057	721	·082	724	·058
784	·087	784	·064	805	·089	787	·063
864	·097	868	·071	868	·097	856	·068
903	·104	937	·078	931	·103	919	·073
993	·110	1000	·083	991	·109	979	·079
1056	·117	1060	·089	1060	·115	1039	·084
1128	·123	1132	·096	1132	·122	1108	·089
1188	·129	1195	·103	1180	·127	1180	·095
1242	·135	1249	·108	1252	·133	1252	·101
1311	·142	1321	·115	1321	·138	1315	·109
1371	·148	1384	·121	1387	·144	1375	·113
1437	·156	1447	·128	1453	·149	1435	·117
1506	·162	1510	·134	1513	·154	1498	·123
1566	·169			1576	·16	1552	·128
1635	·179					1621	·134
						1693	·138-9
						1777	·148

Two minutes elapsed between the weightings in the whole.

B.—Transverse Strain on a simple Rectangular Cast-iron Beam, double the width of A. All else relating to it similar.

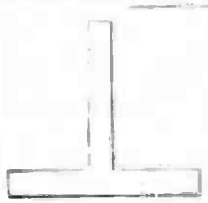
No. 5 Experiment. Weight, 1045 oz.		No. 6 Experiment. Weight, 1063 oz.		No. 7 Experiment. Weight, 1104 oz.		No. 8 Experiment. Weight, 1126 oz.	
Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.
520	·052	820	·043	820	·037	820	·037
928	·057	961	·051	963	·045	955	·047
1072	·065	1099	·057	1083	·052	1099	·055
1195	·072	1246	·064	1215	·06	1231	·062
1321	·078	1390	·071	1347	·067	1363	·069
1465	·085	1528	·077	1488	·073	1483	·074
1591	·093	1660	·085	1608	·08	1651	·084
1735	·099	1786	·091	1785	·09	1783	·091
1861	·106	1930	·098	1893	·097	1942	·1
1981	·113	2074	·107	2001	·103	2083	·107
2149	·120	2206	·116	2124	·11	2206	·116
2287	·127	2338	·124	2250	·118	2359	·123
2425	·135			2388	·127	2503	·133
2573	·142			2520	·135	2629	·141-2
2705	·149			2664	·145	2767	·15
2831	·154			2802	·156		
2969	·160						
3113	·173						

Two minutes elapsed between the weightings in the whole.

C.—Transverse Strain on two simple rectangular cast-iron beams, each similar to A, and placed side by side half an inch apart. All else relating, similar.

No. 9 Experiment. Weight of [illegible] oz.		No. 10 Experiment. Weight of [illegible] oz.		No. 11 Experiment. Weight of [illegible] oz.		No. 12 Experiment. Weight of [illegible] oz.	
Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.
820	·057	820	·047	820	·044	820	·042
952	·062	943	·053	940	·05	952	·048
1096	·067	1075	·061	1066	·058	1081	·054
1222	·072	1207	·066	1222	·066	1210	·061*
1363	·077	1339	·071	1345	·07	1345	·067
1471	·082	1486	·078	1474	·077	1477	·074
1591	·087	1618	·085	1612	·085*	1606	·08
1735	·094	1741	·09	1732	·089	1747	·087
1855	·1	1883	·097	1879	·1274	1876	·093
1999	·107	2015	·103	2017	·133	2023	·1
2119	·112	A small air-hole.		2155	·138	2148	·107
2245	·117			2293	·144	2280	·115
2371	·123			2425	·149	2415	·121
2515	·129			2569	·154	2556	·127
2647	·135			2689	·158	2700	·133
2803	·141			2821	·162		

Both beams broken at once. They were cast from one runner and flowed through at the extreme end.



D.—Transverse Strain on a Cast-Iron Beam, the Section formed of one Rectangle placed centrally upon another and at right angles to it.—Scantlings, and all else relating thereto, similar to C.

No. 13 Experiment. Weight, [illegible] oz.		No. 14 Experiment. Weight, [illegible] oz.		No. 15 Experiment. Weight, 115 oz.	
Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.	Pressure in lbs.	Deflection.
820	·035	820	·037	820	·025
949	·043	955	·042	978	·03
1187	·05	1102	·049	1087	·037
1328	·057	1246	·056	1245	·043
1448	·063	1369	·063	1381	·05
1607	·07	1501	·07	1513	·056
1727	·078	1636	·077	1660	·063
1868	·084	1771	·082	1816	·07
1994	·091	1915	·09	1918	·076
2150	·099	2011	·096	2062	·083
2282	·106	2143	·103	2194	·09
2411	·113	2281	·11	2338	·097
2543	·120	2422	·117	2445	·103
2669‡	·127	2560	·124-6-7	2547	·11
2801	·134	2692	·132	2719	·117
2933	·142	2830	·14	2851	·123
3065	·15	2998	·151	2995	·131
3200	·158	3148	·160-1	3145	·138-140
3344	·167	3286	·170-1	3325	·15-1
3524	·177-9	3412	·176-18	3457	·157-8
3668	·187	3550	·187-9-19	3589	·165
3800	·195	3682	·197-201	3733	·174
3938	·204	3814	·208-9-213	3865	·18
4076	·214-9	3952	·220-223	4003	·189
4102	·226	4090	·232		

* A crack.

† Weights relieved on account of cast-iron leaning piece breaking. Replaced by a wrought-iron piece.

‡ A crack like grain line.

§ Broke, a small air-hole.

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